

Memorandum

Date: January 12, 2004
To: Staff Work Group on Urban Water Use Measurement
From: Eric Poncelet and Bennett Brooks (CONCUR, Inc.)
Re: Draft Definition of Appropriate Urban Water Use Measurement

Please find attached, for your information, a copy of the most recent version of the Program Manager's Draft Definition of Appropriate Urban Water Use Measurement. It incorporates changes proposed during the December 5, 2003 Urban Water Use Measurement Staff Work Group meeting (revisions shown in underline/strike-through). These changes affect only sections II.D, III.A/B, and IV. The Staff Work Group will briefly review this document again at its January 23, 2004 meeting.

Please note that in its present form, this document does not yet respond to two key comments that came out of the December 5th Staff Work Group meeting.

1. It does not yet address the issue of measurement of groundwater banking transfers.
2. It does not yet include a more explicit definition of "groundwater substitution transfers."

CBDA staff and consultants are still working to address these two issues and will provide responses at the January 23, 2004 meeting.

We look forward to discussing this material with you.

Draft Definition

Appropriate Urban Water Use Measurement

California Bay-Delta Authority

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Introduction

Background

This document constitutes the California Bay-Delta Authority's (Authority or CBDA) proposed definition of appropriate urban water use measurement.

The impetus for addressing this topic stems from longstanding stakeholder concerns over the increasing scarcity of California's water resources and recognition of the need for more complete and accurate measurement of urban and agricultural water deliveries. Improved measurement along these lines can assist state and federal agencies in their efforts to achieve the following four key *water management objectives*:

- Provide better information on statewide and regional water use to support planning;
- Allow users to undertake and demonstrate the effects of water use efficiency measures;
- Facilitate valid water transfers; and
- Help the State more effectively administer the existing water rights system.

Recognizing the potential impact of water use measurement on these overarching objectives and the intense stakeholder interest in this topic, the August 2000 CALFED Record of Decision (ROD) called for the CBDA's Water Use Efficiency (WUE) Program to produce a definition of what it termed "appropriate" measurement of urban water use.

Structure and organization of document

The proposed definition of appropriate urban water use measurement is structured into four main sections as follows:

- I. State standards and protocols for recording and reporting urban water use
- II. Measurement of urban water uses
 - Urban water purveyor water sources and production
 - Urban water purveyor customer water uses
 - Urban wastewater discharger wastewater collection and discharge
 - Urban groundwater use
- III. Reporting of urban water uses
 - Urban water purveyor reporting to State of California
 - Urban wastewater discharger reporting to State of California
- IV. Urban water use research program

Each of these sections and sub-sections begins by defining the Authority's current thinking on what constitutes an appropriate level, amount, or reporting of urban water use measurement. This is followed by discussion of: 1) the justifications for the proposed definition, 2) expected impacts (mostly cost-related), and 3) follow-on

considerations. The follow-on considerations will be addressed in the development of an implementation approach (see companion Draft Implementation Approach document).

Guiding perspective and considerations

The perspective by which Authority staff and consultants have approached the task of defining “appropriate” urban water use measurement has been guided in large part by the following question: What level, form, and/or process of urban water use measurement is necessary to better achieve state and federal water management objectives related to planning, allocation, transfer, and water use efficiency?

Authority staff and consultants also based their proposed definition of appropriate measurement of urban water use on the following additional key considerations:

- Declared policy of state of California
- Industry practice and standards
- Empirical evidence demonstrating the efficacy of the proposed measurement definition
- Assessment of need (based upon meetings and interviews with experts in the field as well as background research)
- Prioritization of flow information over water quality information¹
- Practical and achievable steps capable of yielding meaningful benefits to state water management objectives
- Need for an adaptive management approach

Process approach

To inform this proposed definition, Authority staff and consultants have drawn upon the expertise and advice of broad stakeholder and technical expert communities as follows:

- a) In the summer and fall of 2002, the Authority conducted stakeholder interviews with 25 individuals representing a cross-section of water suppliers, environmental organizations, CALFED agencies and partners, business groups, citizen groups, and consultants.
- b) In the spring of 2003, Authority staff convened a multistakeholder Staff Work Group on Urban Water Use Measurement. This group continues to meet to provide feedback on Authority staff’s proposed definition of appropriate urban water use measurement and associated implementation approach (see Attachment 1 for a list of the Staff Work Group members).
- c) In the summer of 2003, Authority staff convened a meeting among urban water use technical and policy experts to better establish the specific information needs driving considerations of urban water use measurement. Authority consultants also conducted a series of targeted follow-up interviews to provide additional

¹ The decision to prioritize flow information over water quality information arose out of consultations with representatives of DWR, DHS, and SWRCB. It is assumed that water quality measurement and reporting are currently adequately handled.

clarity from the perspective of state urban water managers and planners (see Attachment 2 for a list of the meeting attendees and the individuals interviewed).

Anticipated next steps

The Authority intends to take the following next steps to develop an implementation approach to urban water use measurement:

- *Draft implementation plan.* Following Staff Work Group deliberation on the proposed definition, Authority staff, with the continued assistance of the Work Group, will identify and recommend options for implementing appropriate urban water use measurement requirements that are fair, practical, and broadly supportable. Authority staff plans to produce a broadly acceptable outline for an implementation approach by January/February 2004.
- *Conduct broader Authority and public reviews.* Once the proposed definition and implementation plan are drafted, these documents will be submitted for review by and discussion with Authority advisory and decision-making bodies as well as the public. Final revisions will be made at that time. It is possible that this step will incorporate an approach to agricultural water use measurement that is being developed on a parallel track.
- *Initiate legislative discussions.* Once approved, the WUE Program will work with implementing agencies and state policymakers, as necessary, to put forward an implementation approach. It is uncertain at this point whether a final recommended implementation package would necessitate legislative change, administrative changes, or both. Again, it is possible that this step will incorporate an approach to agricultural water use measurement that is being developed through a separate process.

Definition of Terms

Water Meter - includes any suitable water measuring device or facility that measures or determines the volumetric flow of water.²

Water Service - means the sale, lease, rental, furnishing, or delivery of water for beneficial use, and includes, but is not limited to, contracting for the sale, lease, rental, furnishing, or delivery of water, except bottled water.³

Water Purveyor - means any person who furnishes water service to another person.⁴

Urban Water Purveyor – means a water purveyor that provides water service for domestic, municipal, or industrial uses.⁵

Urban Wastewater Discharger – means any discharger subject to an NPDES permit or Waste Discharge Requirement.

NPDES Permit – is a federal permit governing discharge of wastewater to surface waters authorized by the federal Clean Water Act. (In California, authority to issue NPDES permits has been delegated to the State Water Resources Control Board.)

Waste Discharge Requirements – is the state “permit” governing the discharge of wastewater to surface or groundwater in California authorized by the state Porter-Cologne Water Quality Control Act⁶ (For surface water discharges, the State Water Resources Control Board/Regional Water Quality Control Boards issues a combined NPDES permit and WDR; for ground water, only a WDR is issued.)

Reclamation Requirements – is the state “permit” governing wastewater reclamation activities in California issued by the Regional Water Quality Control Boards in lieu of a WDR.

² Cal. Water Code, § 516.

³ Cal. Water Code, § 515.

⁴ Cal. Water Code, § 512. “Person” means any individual, firm, association, partnership, corporation, or public entity of any kind.” Cal. Water Code, § 513. “Public entity” includes a city, county, city and county, whether general law or chartered, a district, board, commission, bureau, authority, agency, department, division, section, any other political subdivision of the state of any kind, or the state.” Cal. Water Code, § 514.

⁵ As such, “Urban Water Purveyors” are not confined to urban areas.

⁶ Cal. Water Code, § 13374.

Definition of Appropriate Measurement for Urban Water Systems

I. State Standards and Protocols for Recording and Reporting Urban Water Use

Appropriate measurement of urban water uses requires the state to develop the following:

- a) Data collection guidelines and protocols for urban water purveyors and wastewater dischargers. At a minimum, the guidelines and protocols need to address (1) estimation of service area population; (2) classification of water supply source measurement data; (3) classification of customer water use measurement data; and (4) classification of wastewater source and disposal measurement data.*
- b) Systems for water purveyors and wastewater dischargers to report urban water use data annually to the state.*
- c) Systems to disseminate urban water use data to local, regional, state, and federal water planning and management agencies and authorities; water purveyors and customers; research institutions and universities; and the general public.*
- d) Guidelines for ensuring the accuracy of the measurement data.*

Justification of Definition:

1. Most urban water and wastewater purveyors in California currently collect vast amounts of data to manage their own systems. This data is not readily obtainable, comparable, or understandable by water managers outside of these utilities. There is a generally recognized need to develop data collection standards and protocols—i.e., determine what kinds of data need to be collected, how this will be done and how this information will be transmitted to others, and measures for QA/QC. Standardizing to some degree how urban water purveyors compile and provide data to state and federal water planners is an essential step in achieving the state’s overarching policy objective of determining and communicating the quantities of water in use throughout the state to the maximum extent reasonable.⁷ The absence of standards for urban water use data collection and reporting greatly diminishes the value of this data for regional and statewide planning and water resource management.

Expected Impacts:

1. The state would incur costs to develop state water data collection guidelines and protocols; provide technical assistance to water and wastewater purveyors implementing the guidelines and protocols; administering data collection processes; and enforcing adoption of any standards. Federal funds for

⁷ Cal. Water Code, § 520. The California State Legislature has declared that, “pursuant to the primary interest of the people of the state to put the limited available supplies of water in this state to beneficial use to the fullest extent of which they are capable, and to prevent waste, unreasonable use, or unreasonable method of use, it is necessary to determine the quantities of water in use throughout the state to the maximum extent that is reasonable to do so.”

developing a statewide reporting system for wastewater discharges subject to NPDES permitting requirements have already been committed. A statewide system for NPDES reporting is projected to be operational in 2005.⁸

2. Some, possibly most, urban water purveyors and wastewater dischargers would incur costs to conform their data collection and reporting systems to the guidelines and protocols.
3. The State as well as urban water purveyors might incur potential cost benefits if the standards and protocols developed enable combination of the multiple existing planning and reporting processes (e.g., DWR, DHS, USBR, CUWCC).

Follow-on Considerations (to be addressed in development of implementation approach):

1. Producing these guidelines/protocols will require collaboration of state level water managers, local water managers and academics and coordination with data collection agencies (e.g., DWR, SWRCB, CPUC, DHS, CUWCC). How should such a process be implemented? What is a realistic timeline for such a process? How would it be funded?
2. Should conformance to the guidelines/protocols be enforceable? If so, what enforcement mechanisms would be appropriate?
3. If it is infeasible to get urban water purveyors and wastewater dischargers to abide by new data collection standards and protocols, should protocols be established for documenting the information that they collect so as to make it more transparent to those using it for regional or state planning and research? Should urban water purveyors and wastewater dischargers be required to develop conversion factors to enable converting data from their own systems to a State-developed standard system?
4. What type of QA/QC is necessary to support these standards and protocols to assure that the data coming in is reasonably accurate?
5. Who would pay for urban water purveyors and wastewater dischargers to conform their data collection and reporting systems to the guidelines and protocols?
6. How should the development of these guidelines/protocols be integrated with ongoing efforts to combine existing planning and data reporting processes (e.g., DWR, DHS, USBR, CUWCC)?
7. What type of database will be best suited to assuring accessibility and dissemination of the data?

⁸ Personal Communication with State Water Resources Control Board; Personal Communication with Environmental Protection Agency, Region 9.

II. Measurement of Urban Water Uses

A. Urban water purveyor water sources and production

*Appropriate measurement of urban water purveyor water sources and production requires the following:**

- a) *Use of suitable water meters at all water source and production points, including source water intakes, treatment works, and storage reservoir outlets. Source water includes surface water, groundwater, and potable recycled water. A suitable water meter is one that is in compliance with relevant standards of the American Water Works Association and any relevant state standards and legal requirements.*
- b) *Source and production meters to be read at least once each month.*
- c) *Source and production meters to be sized appropriately, well maintained, and periodically calibrated to ensure reasonable accuracy.*
- d) *Source and production measurement data to be recorded using standard measurement units and stored by the urban water purveyor using a suitable database management system. Data structures and classification schemes should conform to relevant state water data collection guidelines and protocols (see Section I).*

** Nothing in this definition should be construed to supercede existing state and federal authority and requirements embodied in or through the federal Safe Drinking Water Act and the California Safe Drinking Water Act to impose measurement, monitoring, and reporting requirements on water quality subject to regulation under these acts.*

Justification of Definition:

1. The California State Legislature has declared that, “pursuant to the primary interest of the people of the state to put the limited available supplies of water in this state to beneficial use to the fullest extent of which they are capable, and to prevent waste, unreasonable use, or unreasonable method of use, it is necessary to determine the quantities of water in use throughout the state to the maximum extent that is reasonable to do so.”⁹ Volumetric measurement of urban water purveyor water sources and production is a necessary and reasonable action to determine the quantities of water in use by urban areas in California.
2. The California Public Utilities Commission (CPUC or Commission), pursuant to General Order 103, requires water systems within its jurisdiction to install a suitable measuring device, or otherwise determine production, at each source of supply in order that a record may be maintained of the quantity of water produced by each source. It further requires that at least once each month, the quantity produced from each source of supply be determined. Twelve-month totals by sources are to be recorded and transmitted to the Commission in the utility’s annual report to the Commission.¹⁰
3. As a matter of policy, the American Water Works Association (AWWA) recommends “that every water utility meter all water taken into its system and all water distributed from its system to its users.” AWWA policy further states

⁹ Cal. Water Code, § 520.

¹⁰ California Public Utilities Commission, General Order 103, Rules Governing Water Service Including Minimum Standards for Design and Construction (as amended March 9, 1994), § I.1.a.

that “[m]etering of all water services is an effective means of improving and maintaining the close control of water system operations necessitated by the increasing difficulty in maintaining and providing adequate water supplies and the increasing costs of providing water service to consumers.... Metering provides a database for system performance studies, facility planning, and the evaluation of conservation measures. It also improves accountability for water delivered through the system and, therefore, facilitates management decisions. Periodic performance testing, repair, and maintenance of meters are essential parts of an effective metering program.”¹¹

4. Preparing urban water system water balances, assessing and pinpointing system water losses, and characterizing and managing system water demands require accurate measurement of source water intake, production, and distribution. Empirical evidence conclusively demonstrates the necessity of frequent flow measurement of source water intake, production, and distribution to undertake these management activities.¹²
5. Meter accuracy is a function of correct sizing and proper maintenance. Incorrectly sized and/or poorly maintained source and production meters will result in inaccurate water measurement data.¹³

Expected Impacts:

1. Minimal. The above definition is consistent with standard water industry practice in California. Urban water purveyors may incur some cost to conform their data collection and storage systems to relevant state water data collection guidelines and protocols.

Follow-on Considerations (to be addressed in development of implementation approach):

1. Should the definition include a water purveyor size threshold? The 1991 California Water Use Measurement Law (S.B. 229) exempted community water systems which serve less than 15 service connections used by yearlong residents or regularly serve less than 25 yearlong residents, or a single well which services the water supply of a single family residential home from the requirement to meter new potable water service connections.
2. Who would pay for the installation, maintenance, reading, and recording of water source meters where they do not exist?

¹¹ Adopted by the Board of Directors of the AWWA on Jan. 26, 1969, and revised on June 15, 1980, reaffirmed June 22, 1986, revised June 6, 1993, and June 21, 1998.

¹² Farley, Malcom and Stuart Trow, Losses in Water Distribution Networks, IWA Publishing, 2003.

¹³ Ibid.

B. Urban water purveyor customer water deliveries

Appropriate measurement of urban water purveyor customer water deliveries requires the following:

- a) *Use of suitable water meters at all customer connections to the water delivery system. A suitable water meter is one that is in compliance with relevant standards of the American Water Works Association and any relevant state standards and legal requirements.*
- b) *Customer meters to be read at least monthly if possible, and under no circumstances less frequently than bi-monthly.*
- c) *Customer meters to be sized appropriately, well maintained, and periodically calibrated to ensure reasonable accuracy.*
- d) *Customer measurement data to be recorded using standard measurement units and stored by the urban water purveyor using a suitable database management system. Data structures and customer classification schemes should conform to relevant state water data collection guidelines and protocols (see Section I).*
- e) *Measurement data on water consumed to be forwarded to the customer for the customer's information. This should include previous year data for the same period.*

** Nothing in this definition should be construed to supercede existing state and federal authority and requirements embodied in or through the federal Safe Drinking Water Act and the California Safe Drinking Water Act to impose measurement, monitoring, and reporting requirements on water quality subject to regulation under these acts.*

Justification of Definition:

1. The California State Legislature has declared that, “pursuant to the primary interest of the people of the state to put the limited available supplies of water in this state to beneficial use to the fullest extent of which they are capable, and to prevent waste, unreasonable use, or unreasonable method of use, it is necessary to determine the quantities of water in use throughout the state to the maximum extent that is reasonable to do so.”¹⁴ Volumetric measurement of urban water purveyor customer water uses is a necessary action to determine the quantities of water used for domestic, municipal, and industrial purposes.
2. The California State Legislature has declared that “water furnished or used without any method of determination of the quantities of water used by the person to whom the water is furnished has caused, and will continue to cause, waste and unreasonable use of water, and that this waste and unreasonable use should be identified, isolated, and eliminated.”¹⁵ It has also declared that “waste or unreasonable use of water imposes unnecessary and wasteful consumption of energy to deliver or furnish the water, and it is necessary, therefore, to determine the quantities of water in use throughout the state to the maximum extent that it is reasonable to do so in order to reduce that energy consumption.”¹⁶

¹⁴ Cal. Water Code, § 520.

¹⁵ Cal. Water Code, § 521.

¹⁶ Cal. Water Code, § 522.

3. Since 1991, California law has required meters on all new potable water connections.¹⁷ The 1991 law does not include provisions that the meters be read, just installed. By limiting the metering requirement only to new connections, implementation of the law has resulted in dual measurement systems within some water systems. It has been suggested that this has at best complicated and at worst discouraged a unified measurement and pricing policy to isolate and eliminate waste and unreasonable use of water within these water systems, thereby thwarting the original intent of the legislation.
4. As a matter of policy, the American Water Works Association (AWWA) recommends “that every water utility meter all water taken into its system and all water distributed from its system to its users.” AWWA policy further states that “[m]etering of all water services is an effective means of improving and maintaining the close control of water system operations necessitated by the increasing difficulty in maintaining and providing adequate water supplies and the increasing costs of providing water service to consumers.... Metering provides a database for system performance studies, facility planning, and the evaluation of conservation measures. It also improves accountability for water delivered through the system and, therefore, facilitates management decisions. Periodic testing, repair, and maintenance of meters are essential parts of an effective metering program.”¹⁸
5. Federal law enacted under the Central Valley Project Improvement Act (CVPIA) makes universal metering of urban CVP contractors a condition of CVP contract renewal. The United State Bureau of Reclamation (Bureau or USBR) deems metering of customer deliveries coupled with volumetric pricing an essential demand management practice for CVP M&I contractors. Metering coupled with volumetric pricing is the only non-exemptible Best Management Practice (BMP) required under Bureau Conservation Plan Requirements. Based on review of demands between metered and unmetered service areas, the Bureau has concluded that metering can reduce M&I demands by 20% to 25%. This level of demand reduction is consistent with findings from other empirical studies.¹⁹
6. The California Public Utilities Commission, pursuant to General Order 103, recommends all water sold by a utility be on the basis of metered volume sales.²⁰
7. Retrofitting unmetered customer connections with meters coupled with volumetric pricing is a BMP under the Memorandum of Understanding Regarding Urban Water Conservation in California (MOU). Urban water purveyors providing water service to more than 70% of the state’s populace have

¹⁷ This law became effective January 1, 1992.

¹⁸ Adopted by the Board of Directors of the AWWA on Jan. 26, 1969, and revised on June 15, 1980, reaffirmed June 22, 1986, revised June 6, 1993, and June 21, 1998.

¹⁹ CALFED Water Use Efficiency Program Staff Work Group on Urban Water Use Measurement -- Compilation of Background Information on Current Urban Water Use Measurement Practices, Costs, and Benefits. March 31, 2003.

²⁰ California Public Utilities Commission, General Order 103, Rules Governing Water Service Including Minimum Standards for Design and Construction (as amended March 9, 1994), § I.1.a. It should be noted that under General Order 103 the Commission has discretion to waive metering requirements for a water utility under its jurisdiction.

signed the MOU. Retrofitting unmetered customer connections with meters coupled with volumetric pricing is also a BMP under the Water Forum Agreement.

8. Empirical evidence conclusively demonstrates that metered water service coupled with volumetric pricing can reduce water demand by 20% to 25% or more.²¹ These studies strongly indicate that metering customer uses discourages very low value water uses and wasteful practices.
9. Meter accuracy is a function of correct sizing and proper maintenance. Incorrectly sized and/or poorly maintained customer meters will under-read water flow and result in inaccurate water measurement data.²² Because meters tend to under-read as they age, meter maintenance programs often can pay for themselves through recovered water sales revenue.

Expected Impacts:

1. Urban water purveyors with a large number of unmetered customer connections would incur capital costs to retrofit unmetered connections. It has been estimated that statewide retrofitting of unmetered connections would cost in the neighborhood of \$250 million.²³ Some of this cost would be recouped by water purveyor customers through avoided operation and water system expansion costs due to slower growth in demand. Most urban water purveyor service areas in California, particularly in coastal areas, are already universally metered. Large pockets of unmetered customer connections, however, remain in the Central Valley and Foothill regions. Thus, impacts of the definition would not be uniformly distributed across the state's urban water purveyors, but rather concentrated within a subset of urban water purveyors located mostly in the Central Valley.
2. Urban water purveyors with a large number of unmetered customer connections would incur O&M costs to operate and maintain the new meters. For some purveyors, the O&M costs may be significant.
3. Water purveyors could incur costs to conform to state water data collection guidelines and protocols. Water purveyor data collection and storage systems are designed primarily for customer billing, financial accounting and water system management purposes. These systems are quite heterogeneous across

²¹ CALFED Water Use Efficiency Program Staff Work Group on Urban Water Use Measurement -- Compilation of Background Information on Current Urban Water Use Measurement Practices, Costs, and Benefits. March 31, 2003.

²² Ibid.

²³ CALFED Water Use Efficiency Program Staff Work Group on Urban Water Use Measurement -- Compilation of Background Information on Current Urban Water Use Measurement Practices, Costs, and Benefits. March 31, 2003.. This estimate assumed an average retrofit cost of \$600 per meter and did not account for any upgrades to the delivery network. The average cost per AF of water saved through meter retrofitting has been estimated at about \$350/AF. This estimate assumed an average retrofit cost of \$600 per meter, a 20% average reduction in demand, and a 15-year average useful life for a meter. Compared to recycling and desalination, with costs ranging from \$600 to \$1500 per AF, meter retrofitting would appear to be a cost-competitive alternative.

urban water purveyors. Many may need to be modified to some degree to conform to state water data collection guidelines and protocols.

4. Most urban water purveyors, especially those already metering customer connections, already deliver customer water use data to their customers via their billing systems. Those urban water purveyors with large numbers of unmetered customer connections would incur a cost to retrofit their billing systems to include customer water use data.

Follow-on Considerations (to be addressed in development of implementation approach):

1. Should the definition include an exemption provision? If so what should be grounds for exemption? The MOU and CPUC policy include exemption provisions whereas Bureau policy excludes such provisions. The MOU has three grounds for exemption: (1) a full benefit-cost analysis demonstrates that meter retrofits would not be economically efficient; (2) a water purveyor does not have and cannot obtain funds necessary to implement the BMP; or (3) implementing a meter retrofit program would violate applicable existing law.
2. Should the definition include a water purveyor size threshold? The 1991 California Water Use Measurement Law (S.B. 229) exempted community water systems which serve less than 15 service connections used by yearlong residents or regularly serve less than 25 yearlong residents, or a single well which services the water supply of a single family residential home from the requirement to meter new potable water service connections.
3. Should implementation be phased-in? If so, over what period of time?
4. How should the proposed definition be coordinated/reconciled with existing metering mandates and agreements?
5. Should the definition recommend that volumetric pricing necessarily accompany the customer service metering being advocated?
6. How would the installation, maintenance, and reading of the required customer service meters be funded?
7. What constitutes “reasonable accuracy” for customer meters?
8. Should customer water use measurement also include landscape metering and multi-unit submetering. If so, what thresholds are appropriate? How would the necessary retrofits be funded? How would such requirements be integrated with the CPUC’s existing jurisdiction over submetering?

C. Urban wastewater discharger wastewater collection and discharge

*Appropriate measurement of urban wastewater requires the following:**

- a) *Use of suitable measurement devices at all effluent discharge points capable of measuring and recording continuous flow. Use of monitoring equipment or methods, including, where appropriate, biological monitoring and effluent sampling methods as prescribed by NPDES permits or Waste Discharge Requirements.*
- b) *Effluent measurement data should be recorded and stored by the urban wastewater discharger using a suitable database management system. Data structures and classification schemes should conform to relevant permit/WDR requirements as well as state water data collection guidelines and protocols.*

** Nothing in this definition should be construed to supercede existing state and federal authority and requirements embodied in or through the federal Clean Water Act and state Porter-Cologne Water Quality Control Act to impose measurement, monitoring, and reporting requirements on wastewater discharges subject to regulation under these acts.*

Justification of Definition:

1. Measurement of discharges consistent with the above definition is necessary to implement, monitor, and enforce compliance with various provisions of the federal Clean Water Act (CWA) and state Porter-Cologne Water Quality Control Act.
 - a. The California Porter-Cologne Water Quality Control Act applies to both surface and groundwater and to both point and nonpoint sources. More narrowly, the federal CWA establishes a program to regulate point source discharges to surface waters under the National Pollutant Discharge Elimination System (NPDES). Discharges that are not subject to the CWA but that nonetheless have the potential to affect the quality of the waters of the state remain subject to regulation under the state's Porter-Cologne Water Quality Control Act, which was enacted earlier and is broader in scope than the federal CWA.
 - b. Under the Porter-Cologne Water Quality Control Act, the state regulates, in part, by requiring that persons proposing to discharge first obtain Waste Discharge Requirements (WDRs) from the state. U.S. EPA has delegated the NPDES program to the State of California to implement based on findings that the Porter-Cologne Water Quality Control Act is sufficiently equivalent to the federal Clean Water Act. Accordingly, state-issued WDRs also serve as federal NPDES permits for surface water discharges. [The terms "waste discharge requirements" and "NPDES permits" are often used interchangeably when they cover surface point sources.²⁴] WDRs and NPDES permits are issued and enforced by the Regional Water Quality Control Boards and, when necessary, are further enforced by the State Water Resources Control Board.

²⁴ Cal. Water Code, § 13374.

- c. Issued for varying durations, WDRs and NPDES permits contain monitoring and reporting provisions necessary to evaluate discharger compliance. Monitoring requirements generally include daily effluent flow measurement from the permitted facility along with a variety of water quality monitoring requirements specific to the effluent discharge of the facility and the water quality status of the receiving water body. Permitted dischargers generally submit monthly reports to their Regional Board on daily flow and various water quality parameters.
2. Quantification of discharges will facilitate estimation of urban water uses for statewide and regional planning.
3. Quantification of discharges and water quality assessments will also facilitate estimation of urban water recycling potential for statewide and regional planning.
4. Currently, state water planners do not have a good understanding of water withdrawal and consumption by self-supplied large industrial water users. Quantification of wastewater discharges from self-supplied industrial water users (where they have a separate discharge permit), coupled with information about facility water uses and processes, should facilitate estimation of urban uses for statewide and regional planning.
5. Measurement of effluent flow can by and large serve as a surrogate for influent flow into wastewater discharger facilities, given that the approximate volume of materials being extracted during the treatment process is known.

Expected Impacts:

1. Negligible. The above definition is consistent with standard wastewater industry practice in California. Urban wastewater dischargers may incur some cost to conform their data collection and storage systems to relevant state water data collection guidelines and protocols. However, the state and federal governments are already proceeding with development of a statewide NPDES reporting system and will start transitioning NPDES permit holders to this system in 2004 or 2005. Use of this system for non-NPDES WDRs will follow. Thus, the proposed definition does not represent a change in current or planned measurement and reporting of urban wastewater discharges.

Follow-on Considerations (to be addressed in development of implementation approach):

1. Should urban wastewater dischargers also be required to collect influent data (i.e., volume coming into the treatment facilities)? WDRs already require reporting of influent monitoring (e.g., of flow, water quality parameters) if it is being monitored by the discharger.²⁵ DWR has expressed an interest, in particular, in obtaining influent data from industrial facilities that receive water from private providers drawing largely on groundwater.

²⁵ Personal Communication with State Water Resources Control Board.

D. Urban Groundwater Use

Appropriate measurement of urban groundwater use requires the following:

- a) Continuous regional characterization of groundwater net usage using two methods simultaneously: (1) development of detailed sub-basin hydrologic balances; and (2) the water table/specific yield method. [This is consistent with findings from the Agricultural Water Use Measurement Panel.]
- b) In cases of groundwater substitution transfers where water is being transferred from urban users, continuous measurement (via totalizing flow or power meters²⁶) and monitoring of the groundwater wells involved. Measurement is to be focused on the transferring entity. [This is consistent with findings from the Agricultural Water Use Measurement Panel.]
- c) Measurement (and associated reporting) of individual groundwater extraction as required in adjudicated and managed basins.

Justification of Definition:

1. The California State Legislature has declared that, “pursuant to the primary interest of the people of the state to put the limited available supplies of water in this state to beneficial use to the fullest extent of which they are capable, and to prevent waste, unreasonable use, or unreasonable method of use, it is necessary to determine the quantities of water in use throughout the state to the maximum extent that is reasonable to do so.”²⁷ Quantification of groundwater use is a necessary and reasonable action to help facilitate local, state and federal agency water management and planning.
2. State water planners currently have an incomplete understanding of water withdrawal and consumption by groundwater users, including self-supplied users. Complete information is only being collected for adjudicated and managed basins—i.e., basins already determined to be at risk for overdraft. Improved measurement of net groundwater use in all sub-basins statewide will facilitate estimation of groundwater uses for non-adjudicated basins. This recommended approach represents an improvement in the consistency of the analytic rigor with which the groundwater resources of the state are assessed, and will serve to improve understanding of amounts used and the extent of overdraft. Additionally, where there is a proposal for a water transfer or a project converting land from an agricultural to an urban use (e.g., to a residential development exceeding 500 units), regions that have been measured consistent with the above definition will have improved data available in order to evaluate whether a factual basis exists to support legally required agency findings of fact.
3. There is not currently sufficient evidence to support mandated measurement of all self-supplied urban groundwater uses. Before requiring such direct measurement, further research is needed to better characterize the scope of self-supplied groundwater users (number, impact on overall groundwater use,

²⁶ Measurement via totalizing flow meters is preferred over power meters, as power meters provide only an estimate of groundwater pumped.

²⁷ Cal. Water Code, § 520.

geographic distribution, etc.) and refine the costs and benefits associated with such measurement. This research is called out in Section IV of this definition. [This is consistent with the CBDA-convened Agricultural Water Use Measurement Panel's finding regarding direct measurement of agricultural groundwater use.]

4. Current practice requires direct measurement of groundwater extraction in managed or adjudicated basins. In any suit brought in any civil action in a federal or state court for determination of the rights to water, the court can order that the matter be referred to the State Water Resources Control Board, for resolution of any issue, including investigation and report on the physical facts involved. (Cal. Water Code, §§ 2000, 2001, 2075.) The SWRCB produces a report containing opinions, findings, and conclusions on the applicable law and facts. (Cal. Water Code, §§ 2011, 2012.) The report becomes evidence, before the reviewing court, of the issues referred and reported on. (Cal. Water Code, § 2019.) The SWRCB can also file an action in state court to restrict pumping, or to impose physical solutions, or both, pursuant to statutory procedures. (Cal. Water Code, § 2100.) In addition, individual right holders can turn to the courts to settle disputes. In any of these instances, the courts may appoint a watermaster to oversee implementation of the court's eventual judgment, including measurement and reporting of quantity of water used.
5. In connection with water transfers, California law typically requires that there be no injury to other legal users of the water. DWR has pointed to two steps that help ensure that this "no injury" standard will be satisfied. First, participants should determine the water available for transfer based on conditions that would exist absent the transfer. Second, participants should include real-time monitoring programs to trigger rapid response corrective actions to help avoid possible impacts as they may develop. The first set of measurements help establish a baseline for identifying the quantity available, but also can help ensure that the groundwater to be pumped is not hydrologically connected to the surface supply to be foregone. Thus, measurement, along with other factors such as distance between a well and surface supplies, can help ensure that it is a true transfer. Real-time monitoring is important not only to avoid injury, but also to avoid wrongly attributing adverse impacts to a transfer. That is, after a transfer has started, an adequate monitoring/measurement program can help participants shut off the wells involved in the transfer when they are causing adverse impacts and better know when neighbors' adverse impacts on their own wells are likely due to some other cause (e.g., ordinary seasonal or annual variation in water levels). In addition, the purchaser of water transferred will typically be purchasing it with a price based on volume delivered at a particular time of year when it is most needed. Thus, the purchaser will have it in their own self interest to insist on measurement by the transferor.

Given considerations such as these, DWR has developed nonregulatory guidance to shape its involvement in groundwater substitution transfers. Along with Reclamation where appropriate, DWR has instituted a program to require that adequate measurement and other steps be taken whenever one or more of the following situations exists in a proposed groundwater substitution transfer: (1) DWR is purchasing water; (2) DWR is an operator of facilities through which the

transferred water is to be conveyed; or (3) DWR is a downstream user potentially injured by a proposed transfer.

Expected Impacts:

1. The expected impact on water users of measuring groundwater extraction in adjudicated basin is minimal, as this practice is already required by law and largely implemented.
2. The expected impact of net groundwater use measurement to water users are likely to be minimal. The proposed method of continuous regional characterization will mean higher state planning costs: roughly \$2 million additional per year. Where continuous measurement of well discharge is required in the case of a water transfer, opportunities may exist for costs to be internalized into the transaction costs borne by the participants to the transfer.
3. As water basins become at risk for overdraft and are recategorized as adjudicated or managed, the expected impact on water users becomes large, as this requires all water users to measure groundwater extraction.

Follow-on Considerations (to be addressed in development of implementation approach):

1. The incremental cost estimates for the net groundwater use measurement will need to be confirmed. How will this affect the cost analysis?
2. Benefits from measuring net groundwater use will be fully realized only if coupled with improved measurement of surface water diversions and crop water consumption. How will this be assured?
3. Because net groundwater use is calculated as a closure term under this approach, it may not always allow for urban and agricultural net groundwater uses to be distinguished in non-adjudicated basins. How does this limit the value of this information? To what degree is it important to be able to distinguish industrial from commercial and/or residential self-supplied groundwater use?

III. Reporting of Urban Water Uses

A/B. Urban water purveyor reporting to State of California

Appropriate measurement of urban water uses requires urban water purveyors report annually the following to the State of California:*

- a) An estimate of service area population that conforms to state water data collection guidelines and protocols
- b) The number of metered and unmetered customer connections subtotaled by customer class definitions conforming to state water data collection guidelines and protocols.
- c) Water production by month subtotaled by water source definitions conforming to state water data collection guidelines and protocols.
- d) Annual water deliveries subtotaled by customer class definitions conforming to state water data collection guidelines and protocols.
- e) Monthly or bi-monthly water deliveries, according to meter read frequency, subtotaled by customer class definitions conforming to state water data collection guidelines and protocols.
- f) Water service rates, rate structures, and charges in effect for report year.
- g) ~~Actual versus projected water use for projects covered by SB 610 water supply assessments and SB 221 written verifications of water supply.~~

* Nothing in this definition should be construed to supercede existing state and federal authority and requirements embodied in or through the federal Safe Drinking Water Act and the California Safe Drinking Water Act to impose measurement, monitoring, and reporting requirements on water quality subject to regulation under these acts.

Justification of Definition:

1. The California State Legislature has declared that, “pursuant to the primary interest of the people of the state to put the limited available supplies of water in this state to beneficial use to the fullest extent of which they are capable, and to prevent waste, unreasonable use, or unreasonable method of use, it is necessary to determine the quantities of water in use throughout the state to the maximum extent that is reasonable to do so.”²⁸
2. The California State Legislature has declared that “the people of the state have a primary interest in the orderly and coordinated control, protection, conservation, development, and utilization of the water resources of the state by all individuals and entities and that it is the policy of the state that The California Water Plan, with any necessary amendments, supplements, and additions to the plan, is accepted as the master plan which guides the orderly and coordinated control, protection, conservation, development, management and efficient utilization of the water resources of the state.”²⁹
3. It is the responsibility of the Department of Water Resources to “plan for the orderly and coordinated control, protection, conservation, development, and

²⁸ Cal. Water Code, § 520.

²⁹ Cal. Water Code, § 10005.

utilization of the water resources of the state ... “ and to update this plan – The California Water Plan -- “on or before December 31, 2003, and every five years thereafter.”³⁰ The Department of Water Resource is required by law to release assumptions and other estimates used for the California Water Plan, including, but not limited to, the following:

- a. Current and projected population
 - b. Current and projected water use for all of the following:
 - Interior uses in a single-family dwelling.
 - Exterior uses in a single-family dwelling.
 - All uses in a multifamily dwelling.
 - Commercial uses.
 - Industrial uses.
 - Parks and open spaces.³¹
4. The Department of Water Resources administers annually a survey of about 700 urban water purveyors to collect the data listed in the proposed definition.³² The Department has indicated that the present approach suffers from the following shortcomings:
- a. Individual surveys are frequently incomplete or improperly filled out. Unmetered service areas in particular are unable to provide data on deliveries to different customer classes or must estimate these deliveries.
 - b. About 50% of responses don't report water deliveries by customer class either because they don't maintain records on water use by customer class or because their customer classes don't match the survey's categories. As an example, many systems classify multi-family residential water use as commercial whereas the production survey provides a separate category for this use. Guidelines and protocols for classifying urban water users are needed to provide state planners with consistent and comparable data on urban water uses.
 - c. DWR considers the population estimates provided by survey respondents to be unreliable. Experience suggests that many (perhaps most) urban water suppliers do not provide reliable estimates of the total population served by their system. Thus per capita use estimates derived from the data can be inaccurate. Guidelines and protocols for estimating service area population are needed to provide state planners with reliable population estimates.
 - d. The survey does not always provide good geographic representation of urban water uses. In particular, the survey frequently under-samples less

³⁰ Cal. Water Code, § 10004.

³¹ Ibid.

³² One exception is information about water rates and charges, which is currently not part of the survey. Department staff has indicated that information about water rates and charges is needed to make projections of future water demands by customer class for the California Water Plan.

densely populated areas. More comprehensive data collection is required to provide adequate representation statewide.

- e. The survey does not collect water use information for self-supplied residential, commercial, or industrial water users. Because many of these users are in rural areas this compounds the problems associated with under-sampling discussed previously.
 - f. The survey currently does not collect information about water rates or costs. The Department requires information about rates and cost trends to forecast how costs are changing and how this might affect water demand.
- 5. The proposed definition will provide the Department of Water Resources with more comprehensive and accurate data on urban water uses needed for statewide water planning.
 - 6. Data to be collected and reported under this definition is needed by urban water purveyors subject to regional and urban water management planning requirements under state water code sections 10530 – 10546 and 10610 – 10657.

Expected Impacts:

- 1. Reporting requirements for some urban water purveyors will increase. Not all urban water purveyors participate in DWR's current survey.
- 2. Urban water purveyors may incur costs to conform their data collection and reporting system to state water data collection guidelines and protocols.

Follow-on Considerations (to be addressed in development of implementation approach):

- 1. Should the definition include a water purveyor size threshold? The 1991 California Water Use Measurement Law (S.B. 229) exempted community water systems which serve less than 15 service connections used by yearlong residents or regularly serve less than 25 yearlong residents, or a single well which services the water supply of a single family residential home from the requirement to meter new potable water service connections. Likewise small water systems are exempted from Urban Water Management Planning Act requirements. In addressing this consideration it should be remembered that one of the limitations to the Department's current approach is that it does not collect water use information for self-supplied residential, commercial, or industrial water users.
- 2. Are there ways to combine existing planning and data reporting processes (e.g. DWR, DHS, USBR, CUWCC) to minimize reporting overlap?
- 3. Are there compatibility issues between the urban water purveyor reporting requirements recommended in this document and the reporting provisions required by other existing planning processes (e.g., DWR, USBR, CUWCC, DHS)?

C. Urban wastewater discharger reporting to State of California

*Appropriate measurement of urban water uses requires urban wastewater dischargers report at least annually the following to the State of California:**

- a) Conditions and limits of discharge specified in relevant NPDES or WDR permits.*
- b) Volume of effluent from each discharge location.*
- c) Effluent discharge and receiving water body quality measurements as specified by the relevant NPDES permit or WDRs.*

**Nothing in this definition should be construed to supercede existing state and federal authority or requirements embodied in or through the federal Clean Water Act and state Porter-Cologne Water Quality Control Act to impose measurement, monitoring, and reporting requirements on wastewater discharges subject to regulation under these acts.*

Justification of Definition:

1. Water Code section 13166 requires the State Water Resources Control Board, with the assistance of the Regional Boards, “to prepare and implement a statewide water quality information storage and retrieval program. Such program shall be coordinated and integrated to the maximum extent practicable with data storage and retrieval programs of other agencies.”
2. State compilation of NPDES permit information is needed to fulfill the state’s NPDES permit reporting obligations under Title 33, Chapter 26, Subchapter IV of the US Federal Code.
3. Compilation of wastewater discharge data will facilitate estimation of urban water uses for statewide and regional planning. Currently the Regional Boards in a variety of ways house data on permitted discharges. Mostly this data is collected and filed using paper-based reporting systems. Little of this information is currently stored in electronic format, rendering much of it inaccessible from a practical standpoint. State data warehousing would enable currently collected data on wastewater discharges to be used for a variety of regional, state, and federal water management purposes, including, but not limited to: (1) monitoring, reporting, and enforcement responsibilities specified by CWA and Porter-Cologne Act; (2) State Water Plan updates; and (3) regional and state recycled water planning.
4. Currently, state water planners do not have good understanding of water withdrawal and consumption by privately- or self-supplied large industrial water users, especially when the source is groundwater. Quantification of wastewater discharges from self-supplied industrial water users (where they have a separate discharge permit), coupled with information about facility water uses and processes, should facilitate estimation of urban uses for statewide and regional planning. While discharge data from these permitted facilities is collected by the Regional Boards it is not centrally stored or accessible. State data warehousing would allow access to this data.

Expected Impacts:

1. Minimal. The state and federal governments are already proceeding with development of a statewide NPDES reporting system and will start transitioning NPDES permit holders to this system in 2004 or 2005. Use of this system for non-NPDES WDRs will follow. Thus the proposed definition does not represent a change in planned measurement and reporting of urban point source discharges.

Follow-on Considerations (to be addressed in development of implementation approach):

1. Should urban wastewater dischargers also be required to report influent data (i.e., volume coming into the treatment facilities)? Most WDR permits already require influent monitoring (e.g., of flow, water quality parameters).³³ DWR has expressed an interest, in particular, in obtaining influent data from industrial facilities that receive water from private providers drawing largely on groundwater.

³³ Personal Communication with State Water Resources Control Board.

IV. Urban water use research program

Appropriate measurement of urban water uses requires the state to implement and sustain an urban water use research program.

Highest priority: The following research areas have been identified as having significant potential impacts on state/federal water management and planning efforts and should be given the highest priority: The state will establish a budget and timeline for accomplishing each of these:

- a) Metering Measurement of irrigated landscape water use. These studies should address, at a minimum, the following questions:
 - What are the benefits of more precise measurement of irrigated landscape use?
 - Do dedicated landscape meters (or other technologies such as ET controllers or remote sensing) have a measurable impact on landscape water use when compared to landscapes served by mixed-use meters, after controlling for climate, price, and policy variables?
 - Are dedicated landscape meters (or other technologies such as ET controllers or remote sensing) necessary to the effective implementation of landscape budget and pricing programs, or can such programs be implemented in the presence of mixed-use meters?
 - Are the planning, management, and water supply benefits that may be realized by dedicated landscape meters (or other technologies such as ET controllers or remote sensing) sufficient to justify the costs of the policy?

Other priorities: Other research topics that have been defined as important include (but are not limited to):

- b) Submetering in multi-family dwellings.
- c) Contributions of self-supplied urban groundwater use (including industrial, commercial, and residential users) to net groundwater usage. These studies should address, at a minimum, the following questions:
 - What is the scope of self supplied groundwater use with respect to: number of self-supplied users, type of use, impact on overall groundwater use, geographic distribution, etc.?
 - With respect to groundwater extractions in adjudicated and managed basins, what data is being collected by watermasters? To what degree is this data being collected in a consistent fashion? And to what extent does this data help the state meet its water management and planning objectives?
- d) Residential, commercial, and industrial water end use studies
- e) Urban land use changes and associated changes in water uses
- f) Efficacy of alternative urban water use forecasting methods
- g) Economic studies addressing:
 - Value of water in alternative urban uses
 - Household water use decision-making
 - Commercial and industrial water use decision-making
 - Water demand reduction potential of emerging conservation technologies and programs
- h) Evaluation of the methodologies (and the consistency among these methodologies) by which urban water suppliers and local agencies (cities and counties) develop actual versus projected water use for projects covered by SB 610 water supply assessments and

SB 221 written verifications of water supply (verifications and assessments may be prepared by local agencies if there is no water supplier).

Research results and adaptive management: *The state should take into consideration the results of the research program to re-evaluate annually its definition of appropriate measurement of urban water uses as defined previously in Section II.*

Justification of Definition:

1. Improving the state's ability to forecast and plan for future urban water demands requires a fuller understanding of how water is used in urban areas and how this use is changing over time due to changes in land use patterns, demographics, technology, and economics.
2. A frequent criticism of previous State Water Plan Updates is the use of very general and simplified assumptions to predict future urban water demand. A robust and sustained research program could provide the Department of Water Resources with tools (e.g. a statewide urban GIS of urban land and water uses) and information (e.g. value of water in alternative urban uses) that would substantially improve its ability to make regional urban water use forecasts.
3. A fuller understanding of how water is used in urban areas would support regional water management planning activities authorized under California Water Code sections 10530 through 10546 (Integrated Regional Water Management Plans) and 10610 through 10657 (Urban Water Management Plans).

Expected Impacts:

1. State and/or urban water purveyors and wastewater dischargers would incur cost to fund research program.

Follow-on Considerations (to be addressed in development of implementation approach):

1. Who would administer the research program? Should it be housed within a university, research institute, or state agency?
2. How would such a program be funded? Would water user fees be an appropriate source of funding? What would be an appropriate cost share between federal, state, and local entities?
3. How would the results of this research be disseminated to local water suppliers and wastewater dischargers?

ATTACHMENT 1

Participants – Staff Work Group on Urban Water Use Measurement

Water Suppliers

Angela Anderson - Water Conservation Administrator, City of Sacramento
Dick Bennett - Water Conservation Administrator, East Bay Municipal Utility District
Luis Generoso - Water Resources Manager, City of San Diego Water Department
Mike Hollis - Director, Conservation, Metropolitan Water District of So. CA
Joe Lima - Water Use Manager, Modesto Irrigation District
Rich Plecker - General Manager, Fair Oaks Water District
Tim Treloar - Asst. District Manager, Bakersfield District, California Water Service Co.
Steve Macaulay - Executive Director, California Urban Water Agencies

Environmental Groups:

Roberta Borgonovo - Water Director, League of Women Voters—CA
Dana Haasz - Research Associate, Pacific Institute
Ed Osann - Consultant, Natural Resources Defense Council
Betsy Reifsnider - Executive Director, Friends of the River
Fran Spivy-Weber - Executive Director, Policy, Mono Lake Committee
Eric Wesselman - Regional Representative, Sierra Club (CA-NV-HI Field Office)

Environmental Justice Organizations:

Michael Stanley-Jones - State Director, California Clean Water Action

Business Organizations:

Darin Gale - Governmental Relations Mgr, Sacramento Metropolitan Chamber of Commerce
Brian White - Legislative Advocate, CA Building Industry Association

CBDA Implementing Agencies and Partners

Jeff Barnickol - Statewide Assistance Section, Chief, State Water Resources Control Board
Lucille Billingsley - Water Conservation Specialist, Bureau of Reclamation
Nadine Feletto - Safe Drinking Water State Revolving Fund, Department of Health Services
David Todd - Supervising Land and Water Use Analyst, Department of Water Resources
Mary Ann Dickinson - Executive Director, California Urban Water Conservation Council

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David Mitchell - M.Cubed
Lee Axelrad - Resources Law Group
Bennett Brooks - CONCUR, Inc.
Eric Poncelet - CONCUR, Inc.

ATTACHMENT 2

Participants – June 3, 2002 Urban Water Measurement “Brainstorming” Session

Scott Matyac (DWR)
David Todd (DWR)
Monique Wilbur (DWR)
Scott Hayse (DWR)
Tracy Slavin (USBR)
Lucille Billingsley (USBR)
Nadine Felleto (Dept. of Health Services)
Mary Ann Dickinson (CUWCC)
Mike Hollis (Metropolitan Water District)
Warren Teitz (Metropolitan Water District) – *by phone*
Dana Haasz (Pacific Institute)
Eric Wesselman (Sierra Club)
Peter Vorster (Bay Institute) – *by phone*
Tom Chestnut (A & N Technical Services, Inc.) – *by phone*
Bill Madaus (Maddaus Water Management)
Julio Sanchez (Conservation)
Anil Bamezai (Western Policy Research) – *by phone*
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Follow up interviews – Urban Water Use Measurement Experts

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Tracy Slavin (USBR)
Jay Lund (University of California – Davis)
Jacque De Bra (City of Davis)